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THE DAILY INFLUENCES OF ASTRONOMY[1]

IN the great struggle through which the principal nations have passed, men and women at home labored intensively to maintain their ideals; countless millions of men fought valiently and many millions died for the ideals of their nations. Quick results, short cuts to the end in view, the achieving of victory regardless of costs, were the order of the day. Suddenly the problems of war gave way to the problems of peace. The intensive methods of war carried over to an unfortunate degree into the days of peace. Human energy, mobilized in behalf of the nation, applied unselfishly for the good of every person in the nation, for the well-being of all the nations, was diverted in regrettable measure to promoting selfish interests. The moral exaltation of the war period was replaced in too many cases by the selfishness of individuals and organizations; by profiteering—a new word, coined to describe widespread conditions. The struggle in Russia, as the extreme case, is direct action for the sudden attainment of certain results, without due consideration for the rights of others. In all countries there are those who, seeing conditions not to their liking, in commerce, in education, in religion, in many phases of daily life, would cut and slash their way through the good, in order to uproot what, in their sight, is bad. This spirit exists in America, and throughout the world, in various degrees. Disturbances in the body politic may ensue for years or a generation by virtue of these attempted short cuts to results, but radical transformations in the social structure of the great modern nations, to endure, must find

[1] Address on the occasion of the dedication of the Warner and Swasey Observatory, Case School of Applied Science, Cleveland, on October 12, 1920.

the people ready for them. The influences which prepare the way for desirable and enduring reforms are not those applied suddenly, but such as operate day and night, continuously, through long periods of time. The revolutions in Russia, in Mexico, in many parts of Latin America attract our attention, but the really serious misfortunes of those lands lie much deeper, in their bad social, educational, economic conditions, which are operating unfavorably upon their civilizations every day of the year.

We may well inquire what it is that bears a nation onward and upward to greater things. It is unquestionably the spirit of idealism radiating from its various activities. It is the idealism in commercial life: that part of every man's affairs which is conducted with full respect for the rights of others; that part of every man's business which would not, through its publication, injure his good name. It is the idealism of the transportation system, which interchanges commodities to mutual advantage, and acquaints one section of the world with the good things of other sections. It is idealism in banking, in farming, in the honest day's labor at an honest wage. It is idealism in the intellectual life: reverence for the truth, a desire to know the truth, and to live in harmony with the truth in one's surroundings.

A pessimist would to-day, as always, receive short shrift, yet I venture to say the world was perhaps never more urgently in need of the biblical advice, "Prove all things; hold fast that which is good." This expression of great wisdom has never been surpassed as a statement of the principles which govern men of science in their search for the truth.

The chief value of scientific method and accurate knowledge lies not in their worship by the intellectual few, not in their applications to industry, but in their influence upon the daily life of the people. The remarkable advance in civilization within the leading nations in recent centuries has been due to the daily and hourly influence of the scientific spirit, more than to any other element. Those nations which possess it are forging ahead by leaps and bounds, and those which do not are dropping out of the race. The unscientific nations are threatened with absorption by their more scientific neighbors, not so much because they do not invent or perfect the most powerful cannon, the sturdiest dread-naught, the speediest airplane, or the subtlest submarine, but because the scientific nations are forging ahead of them in the arts of peace, in the modes of thought, in the affairs of daily life. The unscientific nations are without serious influence in the world, not because they are unwarlike—the Turks and essentially all Mohammedans are warlike enough to suit everybody—but because they are lacking in the vision and the efficiency which accompany the scientific spirit.[2]

History affords no more remarkable phenomenon than the retrograde movement in civilization which began with the decline of the Roman power and continued through more than a thousand years. There had once existed a wonderful Greek civilization, but for twelve or fifteen centuries it was so nearly suppressed as to be without serious influence upon the life of the European peoples. Greek literature, one of the world's priceless possessions, not surpassed by the best modern literatures, was as complete two thousand years ago as it is to-day. Yet in the Middle Ages, if we except a few scattered churchmen, it was lost to the European world. A Greek science never existed. Now and then, it is true, a Greek philosopher taught that the earth is round, or that the earth revolves around the sun, or speculated upon the constitution of matter; but excepting the geometry of Euclid and Archimedes, we may say that nothing was proved, and that no serious efforts were made to obtain proofs. There could be no scientific spirit in the Greek nation and Greek civilization so long as the Greek religion lived, and the Greek people and government consulted and were guided by the oracles. If there had been a Greek science equal in merit

[2] This and the following paragraph have been taken, with but few changes, from one of my earlier addresses.—W. W. C.

to modern science, think you that stupidity and superstition could have secured a stranglehold upon Greek civilization and have maintained a thousand years of ignorance and mental degradation? Intellectual life could not prosper in Europe so long as dogma in Italy, only three hundred years ago, in the days of Bruno and Galileo, was able to say, "Animals which move have limbs and muscles; the earth has no limbs or muscles, therefore it does not move;" or as long as dogma in Massachusetts, only 250 years ago, was able to hang by the neck until dead the woman whom it charged with "giving a look toward the great meeting house of Salem, and immediately a demon entered the house and tore down a part of the wainscoting." The morals and the intellect of the world had reached a deplorable state at the epoch of the Borgias. It was the re-birth of science, chiefly of astronomy, as exemplified by the work of Columbus and Copernicus, and secondly the growth of medical science, which gave to the people of Europe the power to dispel gradually the unthinkable conditions of the Middle Ages.

It has been said that we may judge of the degree of civilization of a nation by the provision which the people of the nation have made for the study of astronomy. A review of present-day nations is convincing that the statement represents the approximate truth. It is essentially true even of sections of our own country. In our first years as a nation a few small telescopes were in private hands, here and there; they were used merely for occasional looking at the stars; there were no observatories in the United States—no telescopes suitably mounted and housed for the serious study of the stars. The founding of the third American observatory, at Hudson, Ohio, about 1839, only a year or two after the completion of the second observatory, at Williams College, Massachusetts, was an admirable index to the intellectual outlook of the Western Reserve.[3] The laying of the corner stone of the Cincinnati Observatory in 1843, a wonderfully ambitious institution for its day, was an event considered by Ex-President John Quincy Adams to be worthy of a hard trip, in the seventy-seventh year of his life, by rail from Massachusetts to Buffalo, by lake steamer to Cleveland, by four days of miserable canal boat to Columbus and thence on to Cincinnati, to deliver the formal address —then called an *oration*. Adams's task was, to quote his words, "To turn this enthusiasm for astronomy at Cincinnati into a permanent and persevering national pursuit, which may extend the bounds of human knowledge, and make the country instrumental in elevating the character and improving the condition of man upon earth."

Our former slave states have to-day only one active observatory, at the University of Virginia, presented by McCormick of Chicago. Barnard and other astronomical enthusiasts, born and grown to manhood in the south, have found their opportunities in the great northern observatories. What is true of astronomy in the south is true, in general, of the other sciences. This unfortunate result is the natural product of the false, unscientific system of labor which, prevailing through many generations, taught that it is undignified for the white man to eat bread by the sweat of his own brow. Financial recovery, following 1865, has accordingly been slow. The future will correct this, for the men of the south are our blood brothers. We should be, and are, sympathetic.

Shall we try to estimate what astronomy, the oldest of the sciences, sometimes called an ideal and unpractical science, has done for mankind?

Here are some of the applications of astronomy to daily life.

1. Observations of the stars with the transit instrument, such as exists in this observatory, are supplying the nations with accurate time. Two astronomers, with modern instrumental equipment, situated on the same north and south line, may observe the stars so accurately, in comparison with the beats of their common clock, that they will agree

[3] The northeastern part of Ohio constitutes the "Western Reserve."

within two or three hundredths of a second as to how much that clock is fast or slow.

2. The accurate maps of the continents and islands depend upon the astronomical determinations of the latitudes and longitudes of their salient features.

3. The sailing of ships over long courses, say from the Golden Gate to Sydney, Australia, or from New York to the Cape of Good Hope, depends upon the A B C's of astronomy. Given fair skies the navigator may locate his ship in the middle of the broad ocean within a mile of its true position.

4. In America it is the habit to call upon the astronomers to fix the boundary lines between nations, by observations of the stars; for example, along the 49th parallel of latitude, from Rainy Lake, Minnesota, westward almost to the Pacific Ocean. The uncertainty as to where this imaginary line falls upon the ground is nowhere greater than ten or fifteen feet, and it has not been found necessary by us, nor by our friends in Canada, to maintain military forts along that line.

5. The times of high and low tides, vital to mariners in entering many harbors, are determined by or from the work of the astronomers.

We do not dwell upon these responses to the immediate needs of the world, for they are unimportant in comparison with the contributions of the pure knowledge side of astronomy to progressive civilization.

Let us think of the earth as eternally shrouded in thick clouds, so that terrestrial dwellers could never see the sun, the moon, the comets, the stars, and the nebulæ, but not so thick that the sun's energy would fail to penetrate to the soil and grow the crops. Under these conditions we might know the earth's surface strata to the depth of a mile or two. We might know the mountains and the atmosphere to a height of four or five miles. We might acquire a knowledge of the oceans, but we should be creatures of exceedingly narrow limits. Our vision, our life would be confined to a stratum of earth and air only four or five miles thick. It would be as if the human race went about its work of raising corn for food and cotton for raiment, always looking down, never looking up, knowing nothing of the universe except an insignificantly thin stratum of the little earth. This picture is only a moderately unfair view of life as it existed on our planet four hundred years ago, before the days of the telescope, the spectroscope and the photographic plate, before the days of freedom of speech and thought, which came with the scientific spirit. The earth is for us no longer flat, supported on the back of a great turtle, which rests upon nothing. It is round, and every civilized person knows that it is. Exists there an intelligent man in the world whose thoughts, every day and many times a day, are not unconsciously adapted to this fact? This knowledge is a chief inheritance of the new generations. It is fundamental in our civilization. People know that the sun will rise in the morning and set in the evening, and why. A round earth, rotating upon its axis in a dependable way and revolving around the sun in exact obedience to law, are truths incomparably more sublime than the fiction of the flat earth which was pictured hazily in men's minds during pre-Copernican days. Who can estimate the value of this knowledge to the human race? It can not be expressed with the few figures which suffice for the total of present-day financial transactions.

The stars are not lanterns hung out in the sky by angels at night, but something inconceivably grander; they are suns, hundreds of millions of suns, on the average comparable in size and brightness to our sun. Is not this ascertained fact of nature a most ennobling one to aspiring souls? Do not these facts suggest and develop becoming modesty in the minds of those who would know the truth and pattern their lives in accordance with it?

The following conversation occurred one Saturday evening in the month of June, 1912, at the eyepiece of the great telescope which Mr. Warner and Mr. Swasey constructed and erected for the Lick Observatory: I mention the time, June, 1912, because it is of the essence of the story.

Said the astronomer to the party of visitors: "The object which you will see through the great telescope this evening is the star cluster in Hercules, the finest cluster in the northern sky. Without the telescope, by naked eye, this cluster may be seen if the observer knows exactly where to look and has first-class eyes, but he will see it as apparently a single star on the limit of vision, so faint that many eyes will not see it at all. The telescope separates the cluster into a multitude of stars. If you had the time to count them, they would number fully six thousand, closely grouped in the center of the cluster, but thinning out as you approach the edges. This one object, then, which to the naked eye seems to be a single star on the limit of vision, consists of at least as many stars as the eye alone is able to see in the sky as a whole, northern and southern skies, summer and winter skies combined, and we do not doubt that long photographic exposures on the cluster, with a large reflecting telescope, would record many more than six thousand. Each of these stars is a sun and probably every one of those which you will see is larger than our sun,, for we are observing merely the brightest members of the system. We do not know whether these suns have planets revolving around them or not, as the cluster is entirely too far away for us to see such planets, but planets probably exist there in great numbers; possibly there are planets revolving around all of those stars; possibly and probably there are moons revolving around the planets; and finally, there may be life, vegetable, animal, intelligent life upon those planets."

One of the visitors upon descending from the observing chair, much interested, questioned the astronomer: "Did you say those stars are all suns?" "Yes, sir." "Did you say that those stars are really larger than our sun, on the average?" "Yes, sir." "Can you give me an idea how large our sun is?" "Well, if it were a hollow shell, of its present size, you could pour more than a million earths into it, and there would still be much unoccupied space between the earth balls." "You say, there are possibly or probably planets revolving around many of the cluster stars?" "Yes, sir." "And many of those planets may be inhabited?" "Yes, sir." "Well then, I think it does not matter very much whether Roosevelt or Taft is nominated next week at the Chicago Convention."

Of course the visitor's interest in the outcome at Chicago was just as keen as ever, but he had evidently received a valuable lesson concerning man's place in nature.

The wonders of our sun are many and most remarkable, and are but little known. I have referred to its enormous size. The quantity of heat which the sun is radiating into surrounding space, to the earth, to Mars, and to all other objects which intercept its rays, is stupendous and not to be comprehended by the astronomer or the man of affairs. It is, and has been, the source of all the energy upon which we draw, save only a negligible residual. A great quantity of heat is indeed stored up in the interior of the earth, but it reaches the earth's surface in such minute quantities that in all practical details of life, save to those who labor in deep mines, or live near volcanoes, or are interested in hot springs, this source of energy may be neglected. If this statement should be difficult to accept, let your thoughts travel to the south pole of our planet. What does the interior heat of the earth do for that region? The antarctic continent's perpetual covering of ice and snow is unaffected by it, nor does the actually enormous quantity of solar heat falling upon that continent suffice to remove the white mantle. If aught should intervene to cut off the sun's energy from the earth for one short month, the tropics would attain to a state of frigidity to which the south polar continent, as now observed, would be a rose garden in comparison.

It is the sun's heat which grows the farmer's crops, the trees of the forest and all vegetation. The coal deposits upon which we draw to-day for the running of trains, ships, factories and rolling mills, are but the solar energy of an earlier age, compressed, transformed and preserved for our comfort and power. In the mountainous regions of our

land, where water can be stored in high level reservoirs and, passing through water wheels at lower levels, be made to generate electric power for lighting, for heating and for the running of motors, it is the sun's energy which is transformed to meet the needs of men. The sun's rays evaporate the surface waters of the oceans, lakes, streams and lands; the winds, generated by the unequal solar heating of our atmosphere, transport some of the water vapor to the high mountains, where it is deposited as rain or snow. It is merely the descent of these waters to the lower levels that is controlled by man and transformed into electric power for his own purposes.

It would take more than two billion earths placed side by side to form a continuous spherical shell around our sun at distance equal to the earth's distance, and thus to receive the total output of solar heat. Therefore less than one two-billionth part of that output falls upon the earth. The earth's share of solar energy, expressed in horse-power or other familiar units, is too great to set down in figures. If you should happen to own 250 acres of land in one of the tropical deserts of the earth, you will be interested to know that your quota of the solar energy, near the middle of a summer day, is falling upon your tract of land at the rate of about one-million horse-power—more than enough heat and power to supply all the needs of this great city—and this is but two thirds of the sun's good intentions toward you, for some 40 per cent. of the energy is intercepted by the atmosphere overlying your farm, and returned forthwith to outer space.

Your neighbor's tract of 250 acres is also receiving solar energy at the rate of one million horse power. Figuring backward, if one farm area receives a million horse power, and there are more than a hundred million such farm areas on the earth turned toward the sun at one time, and the whole earth intercepts less than one two-billionth of the sun's energy output, is it any wonder that sun worship became one of the recognized religions? Accurate knowledge saves us from that, but it is becoming in us to give the sun our due respect.

A great problem ahead of the scientific world is the storage of the sun's beneficent heat rays for release as needed. Astronomers are seeking intently for the sources of the sun's outpouring of energy: how can the sun maintain the supply for tens of millions of years, as it undoubtedly is doing? One important source has been found—the sun's own gravitation which tries constantly to pull every particle of its material to the sun's center—but another and greater source seems to await discovery. Does any one say, since the supply of solar energy will surely meet our needs for ten or a hundred million years, why look further for the cause? Why not let it go at that? This selfish spirit, if applied to all subjects, would retrograde our civilization. Even the possession of the truth is not so potent for good as the desire to know the truth, and the struggle to discover it. Practically, a knowledge of the origin of the sun's heat may be the key for locking up great quantities of it on summer days and unlocking it when and where needed.

Who is not interested in Mars, a planet much smaller than the earth, a little over four thousand miles in diameter, which revolves around the sun in somewhat less than two years, at an average distance from the sun fifty per cent. greater than the earth's distance? Mars is literally one of the earth's brothers, and we should be sincerely interested in his welfare. Does life exist on that planet? Almost certainly there is vegetable life. We have no reason to doubt it. Certain areas of the planet change in color as the climatic seasons come and go, very much as we should expect if these colors were controlled by the natural stages of vegetable life. However, in precaution, I should guard against the drawing of the conclusion that vegetable life on Mars has actually been proved to exist. I can merely say that we see no reason to doubt its existence. Is there animal life on Mars? There probably is, but we have no positive evidence that such is the case. If the physical conditions on the planet as to water, air

and soil are such that vegetable life may exist, the chances are strongly in favor of animal life also. However, I think we must leave unanswered for the present the question whether such animal life is highly intelligent. The forests of the St. Lawrence Valley and the prairies of the Mississippi Valley put on their green coats in the spring and changed them to brown coats in the fall, perhaps even better before the coming of man than after his destructive influence descended upon them. If you had the means to ascend several thousand miles above your present position, and could dwell there throughout the year, you would witness the formation of a polar snow cap upon the earth early in the autumn. The southern edge of this cap would extend farther and farther to the south up to the time of mid-winter. Its edge would extend well down toward the southern limits of the United States, to the Himalayas in Asia, and so on. With the coming of spring the north polar cap would decrease in size and probably disappear, save as to snows on the higher mountains and the possible ice and snows of the immediate polar region. An observer similarly situated above South America would witness similar phenomena as to the south polar regions; and these are indeed the phenomena observed on the planet Mars. The white polar caps on Mars wax and wane with the coming and going of the winter as they do upon the earth. Superficially, the Martian conditions seem not very different from the terrestrial, though we know that the Martian atmosphere is highly attenuated, and if we were suddenly set down upon that planet's surface we should certainly suffocate for lack of air. Water is probably scarce upon that planet in similar degree. However, these facts do not militate strongly against animal life upon that planet, for such life would undoubtedly be developed with respiratory and other organs adapted to their environment. A solution of the Martian problems, as to a possible counterpart of terrestrial man on that planet, is apparently not now hopeful, but present-day failures may be the prelude to future successes, and I prefer to offer no discouragement.

The planet Venus, only a shade smaller than the earth, and but two thirds as far from the sun as we, presents a similar but apparently more difficult problem. We know that it has an extensive atmosphere, no doubt comparable with that of the earth, but concerning the presence of water we are justified in making no statement other than that we remain in apparently total ignorance. If Schiaparelli was right, as he appears to have been, that Venus always presents the same face to the sun, just as the moon always turns the same hemisphere toward the earth, then one hemisphere of Venus undoubtedly remains intensely hot in perpetuity, and the other hemisphere in perpetual darkness and excessively low temperature. Can the twilight zone between the hemispheres of day and night offer abode and comfort to living forms, vegetable and animal? We have found no answer to this question, and we know not how to progress to the solution.

Are the moon and Mercury inhabited? Certainly not by such forms of life as we are familiar with, for neither object has an appreciable atmosphere. Both bodies undoubtedly suffer from extremes of heat and cold, without the protecting blanket of atmosphere with which the earth is blessed. The other planets, Jupiter, Saturn, Uranus and Neptune, may be dismissed as uninhabitable by life forms of our acquaintance. There seems no reason to doubt that these great bodies, from four to eleven times the earth in diameter, are still devoid of solid footing for man or beast, such as the rock and soil strata afford upon the earth.

Have astronomers been able to prove that planets revolve around other suns than ours? No, the distances of the nearest stars preclude that possibility to our means in hand. Such planets would need to be many-fold brighter than Jupiter, the greatest of our planets, and our great telescopes would need multiplication many times in diameter to let us see them as attendants of their suns. We are able to prove, and have proved, however, the existence of

hundreds of bodies, in distant space, whose rays of light we have not perceived. The spectrograph has shown with certainty that, of the naked-eye stars, one in four on the average is not the single star which it appears to be to the naked eye, or when viewed in the telescope, but that it is a double sun, the two bodies revolving continuously about their mutual center of mass. These hundreds of binary systems are so far away that even under the highest telescopic magnification they blend into a common and essentially mathematical point. It is the expectation that the future, possibly the present century, will establish that one star in three, on the average, is a double solar system. It may even prove to be the truth that our solar system, consisting of one great central sun and many attendant planets, is not the average and prevailing system, but is the exception and not the rule. However, we have no good reason to doubt that tens of thousands, more probably tens of millions, of distant suns are the centers of planetary systems, and that countless planets are the abode of life. As our sun is but one of hundreds of millions of suns, it is absurd and essentially inconceivable that our planet, or two or three of our planets, should be the only bodies throughout the universe supporting life. It is vastly more probable that if our vision could penetrate to other stellar systems, lying in all directions from us, we should there find life in abundance, with degrees of intelligence and civilization from which we could learn much, and with which we could sympathize. The spectroscope proves absolutely that dozens of chemical elements in the earth's surface strata exist in our sun: that iron, the silicon of our rocks, hydrogen, helium, magnesium and so forth exist in the distant reaches of our stellar system. If there is a unity of materials, unity of laws governing those materials throughout the universe, why may we not speculate somewhat confidently upon life universal?

In the days of my youth, here in northern Ohio, the opinion prevailed throughout the community, and widely over the earth, that comets were the forerunners of wars, plagues or other forms of dire distress. Did not the great comet of 1811 herald the war of 1812, and that of 1843 the Mexican War and Donati's comet of 1858 our Civil War? Even in the twentieth century the fear that a comet may collide with the earth and destroy its inhabitants comes to the surface, here and there, every time a comet is visible to the naked eye. The findings of astronomers concerning these visitors to our region of space have taught that we have nothing to fear from them, and that their close approaches may be welcomed, for they are interesting members of our sun's family. They revolve around our sun as the planets do, and render unto it homage and obedience. It is undoubtedly true that the earth has plunged through the tails of comets many a time and without appreciable effects upon our health and happiness. In fact, the inhabitants have at the time been blissfully unaware of the passage. It is true that a collision of the condensed head of the comet with the earth is not impossible; it may some time occur; but comprehensive studies of this question, based upon observational data concerning many of these bodies, lead indubitably to the conclusion that we must not expect these collisions to occur, on the average, more than once in 15 or 20 million years. The so-called shooting stars, which we have all observed in the night sky, are in many cases, perhaps in all, though we do not know, the burning of minute pieces of comets which have disintegrated and disappeared as comets forever from our sight. Colliding with the earth, rushing through the upper strata of our atmosphere with speeds up to 40 or more miles per second, the frictional resistance of the air heats them to the burning point, and they are turned into ashes and the vapors of combustion. A very few get through to the earth's surface and are found and placed in our museums. It is not certain that any of those in the museums are parts of disintegrated comets, but some of them probably are. The number of small foreign bodies which collide with our planet every day is very great; a conservative estimate is 20,000,000. Except for our beneficent atmosphere man would suffer many tragedies from the bombardment. There is reason to believe that the earth is

growing larger very slowly, from these accretions, and this may have been the process by which the earth grew from a small nuclear beginning up to its present size.

Astronomers have determined that our solar system is very completely isolated in space. We are widely separated from our neighbors. I shall not try your patience by quoting the tremendous distances in miles, for they are incomprehensible to all of us. Rays of light sent out by the sun require a little more than eight minutes to reach the earth. The outermost known planet in our system, Neptune, would be reached in four hours and a half. Rays of light leaving the sun at the same time and travelling at the same rate, 186,000 miles per second, must travel continuously during four years and a half to reach our nearest known neighbor in space, the bright double star Alpha Centauri. If the distance from the sun to the earth is *1*, the distance to our outer planet is *30*, and the distance to Alpha Centauri is *275,000*. There appears to be an abundance of room in the great stellar system to meet the requirements of all. The spectrograph attached to the Lick telescope has determined that our sun and its family of planets is traveling through the great stellar system with a speed of twelve and a half miles per second, equivalent to four hundred million miles per year. The earth is certainly hundreds of millions of years in age, the sun is no doubt at least as old, and the early youth of the earth was lived, not where we now are, but far elsewhere in the stellar system; and its future journeyings will lead to quite other points of observation.

The question of greatest interest to present-day astronomers is that of stellar systems other than our own. The chances seem strong that the hundreds of thousands of spiral nebulæ known to exist in very distant space are other and independent systems of stars, many of them perhaps containing as many stars as our stellar systems. In other words, our stellar system may be but one of hundreds of thousands of isolated stellar systems distributed through endless space. This is not an established fact, but the evidence seems to run in its favor.

I have referred to some of the problems and results of astronomical science. The list of interesting items is a long one, but available time has its limits. In brief, it is the astronomer's duty to discover the truth about his surroundings in space, and make it a part of the knowledge of his day and generation. The ultimate and real value of his work lies in its influence upon the lives of the people of the world, in the changes for the better which it induces in their modes of thought, and in the impulse which it gives to an advancing civilization.

Would that the attractions of the sky to the average man were more potent. It is a curious comment upon the attributes of city life that hundreds of thousands of people, especially children, in London and Paris, in the darkness which gave them semi-concealment from the enemy's destructive air ships, should have obtained their first real vision of the starry heavens. What must have been their sensations? On the other hand, those who can view its beauties and wonders are prone to neglect it; to look down instead of up. Emerson has said somewhere in his immortal essays that if our sky should be clear of clouds but one night in a century, the people of this globe would look forward to the rare event, and not only prepare to behold its beauties themselves, but make sure that their friends far and wide were likewise minded. How the beauties of the night sky would surpass the expectations of the most lively imagination! The wondrous vision would be the prevailing subject of conversation for years and years, and the repetition of the vision, one hundred years later, would need no advertising.

Our knowledge of the heavens is in its infancy. We have but made a start upon the discovery of the truth about the stars, and the results of astronomical research are not so widely known amongst the people as they should be. This splendid institution, The Warner & Swasey Observatory, presented by men who are masters in telescope and observatory design and construction, by men who

have thought much of relative values in life, this institution has a field of great usefulness lying before it. In their administration of the generous gift, the trustees, the president and the faculty of the Case School of Applied Science, whether for research, for school instruction or for community education, will have the sympathetic interest of astronomers, of all lovers of the truth. This observatory may assist in the solution of important problems concerning the universe of which we form a part. The universities, the colleges and the technical schools of our country, and of other countries, are graduating every year many hundreds of young men, ready to start upon the more serious phases of their lives, who can tell us all about the lights in our houses, but not one word about the lights in our sky. This institution will do its quota in approximating to a liberal education. The casual visitor who enters its portals in search of knowledge, yea, the passer-by in the street who merely sees a dignified and purposeful observatory set upon a hill, will have his thoughts directed to higher levels.

W. W. Campbell

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PLAN OF THE BICENTENARY EXPEDITION TO THE NORTH OF GREENLAND

In the year 1721 Hans Egede left Copenhagen for Greenland; with this event the systematic colonization of the vast arctic territory by the Danish State began. In celebrating the bicentenary of this colonization it is natural not only to review what has been achieved, but also to look forward to what still remains to be done both in administration and in research.

The whole coast-line of Greenland is now known. Every point of the coast, extensive as that of a continent, commemorates by its name the glorious achievements of explorers. As a rule, the big nations were before us as far as the discovery itself was concerned, but we may safely say that Danish research has deepened and perfected the knowledge of the new coast-lines. Stubbornly and unweariedly we have carried our flag to the North on both coasts.

The coast of Peary Land, the remotest, most inaccessible part of Greenland we have reached from both sides. The "Danmark" Expedition reached Peary's Cairn on Cape Bridgeman and the Second Thule Expedition, in which I took part myself, reached the De Long Fiord. There still remains a stretch of coast which no Dane has ever seen, and the interior of this country, almost as large as Denmark, is absolutely unknown.

On the Second Thule Expedition, conducted by Knud Rasmussen, it fell to me not only to map out great ice-free territories, which had hitherto been unknown, but also to demonstrate that these new territories are geologically among the most interesting in Greenland, and that the so-called Caledonian Fold, which had hitherto been known to exist only in northern Europe stretched across to the other side of the Atlantic.

Though our results are confirmed by the collections which we succeeded in bringing home in spite of the greatest difficulties, I realized even while working in the field, that great problems still remained to be solved. Another expedition is planned the aim of which will be exclusively geological and geographical research.

Headquarters with a wintering station will be established in Robertson Bay in Inglefield Gulf. From here the following expeditions will be made:

1. A large provision cache for future journeys is to be taken across the Inland Ice from Inglefield Gulf to Warming's Land.[1] The transport will take place in the late summer, when the temperature is comparatively high and the surface snow is melted down or compressed. For this reason it is to be undertaken by Cleveland Tractors, which will be able to work across the ice-free marginal zone at Inglefield Gulf.

[1] South of Sherard Osborne Fiord. The writer's map of the regions surveyed by the Thule Expedition has been printed and will soon be published.